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Fifteen individual grains were analyzed, and their variation was from 1.72 per cent. to 2.30. These figures show that, to make selection most effective, we must be able to separate the desirable kernels from the less so, and not depend simply on selection of ears. Upon this problem we are still at work. It is evident that we cannot analyze our kernel, and plant it too, and that some physical test only is available. Our task is to find a usable physical property which varies with the per cent. of nitrogen. The specific gravity suggests itself as best adapted to our needs. Investigation of this point has not yet reached definite results. The differences in specific gravity are very slight, and since parallel determinations of the nitrogen in single kernels are impracticable, a large number of analyses will be necessary before a positive result can be expected. The determination of the specific gravity, while theoretically simple by means of a heavy solution and the Westphal balance, presents considerable difficulty because of the adherence of air to the grain with great tenacity, and because of the occurrence of cavities within the kernels sometimes.

Analysis of the several parts of the grain has shown that the germ is much the richest in nitrogen. Constituting about ten per cent. of the weight, it contains sixteen per cent. of the nitrogen. It also contains sixty-five per cent. of the oil. An increase in the size of the germ, therefore, will insure an increase in the percentage of the most valuable parts. Differences in the size of the germ are easily seen by simple sections through the kernels with a sharp pocket-knife, and ears can be selected showing a predominance of large germs.

WATER PURIFICATION.

BY W. TWEEDDALE, TOPEKA.

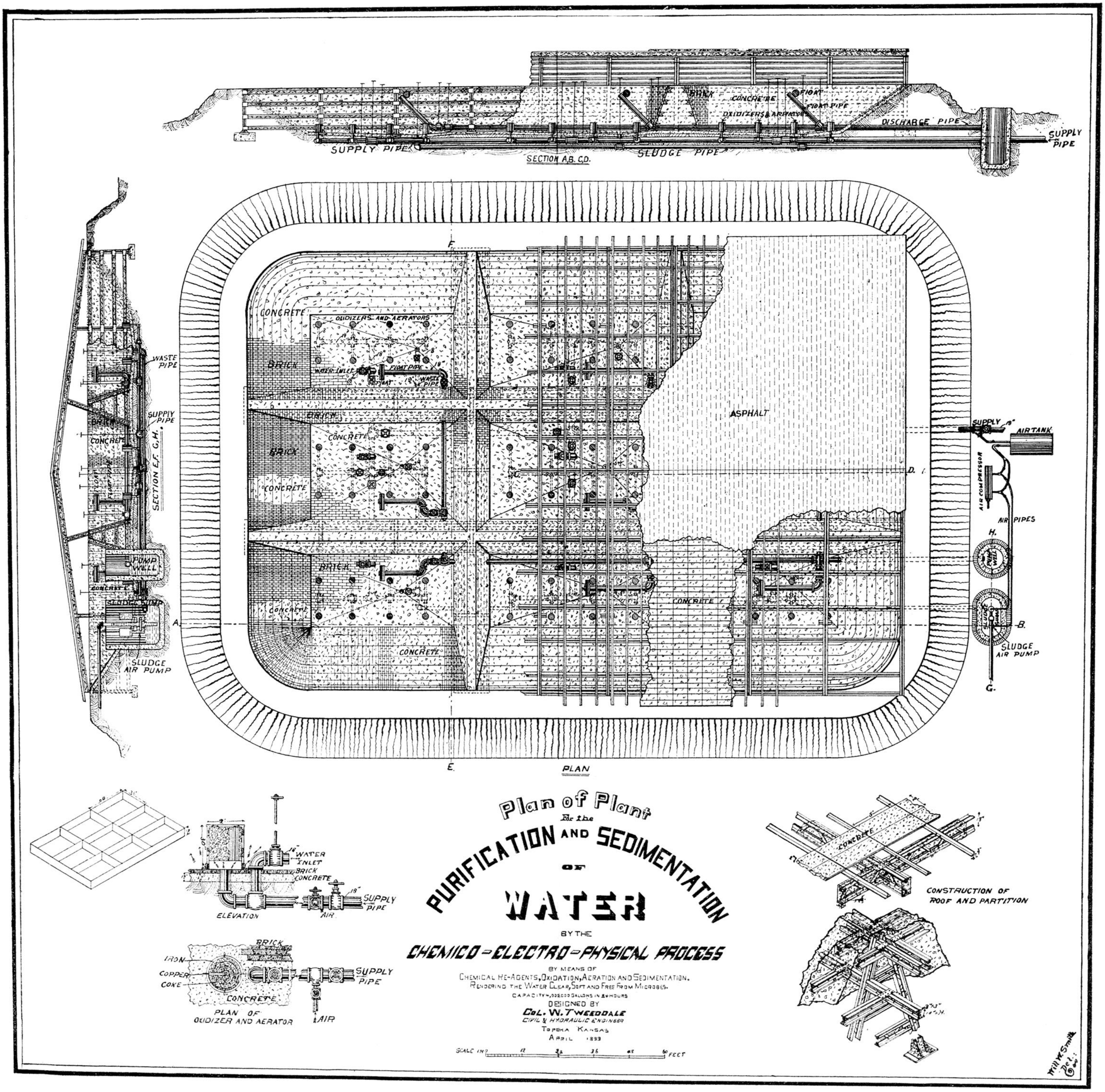
Read before the Academy December 30, 1898.

The character of the water-supply of a country is the determining element of its potential future, as regards its being the habitation of man, whether it be by the solitary pioneer or a community of individuals, as in ranch, village, town, or city like New York, with a population of millions.

Modern sanitation requires that not only shall the quantity be abundant, but that the quality shall be suited to the uses to which it is to be applied. Medical science forbids that the cholera-infected water in the sacred tanks of India be longer used for dietetic purposes; and in the same line demands that, if water for potable purposes cannot be procured, provision be made to render it so by some system of purification. The necessity for this purification is due to the very solvent power of water acting on solid substances, such as clay, the presence of which in a state of suspension causes turbidity, together with the solvent power of gases in water acting chemically on inorganic earth salts, causing the property termed hardness and the fermentation (putrefactive decomposition) of organic substances, the presence of which in this state constitutes the nidus for the development of bacteria.

In this country the purification of public water-supplies has been mainly restricted to the removal of visible impurities in suspension, including bacteria. This is sought to be done by filtration or by subsidence. There are two systems of filtration: 1st, sand filters, English system, as it is termed, with or without being allowed to deposit the coarser particles by sedimentation; and, 2d, the mechanical filters, American system, combined with the use of a coagulant.

Subsidence is the practice in cities whose sources of supply are the waters ob-


BRICK
CONCRETE
FLOAT
FLOAT PIPE
OXIDIZERS & AERATORS
DISCHARGE PIPE
SUPPLY PIPE
SUPPLY PIPE
SECTION A.B. C.D.
SLUDGE PIPE
WASTE PIPE
SUPPLY PIPE
BRICK
CONCRETE
SECTION E.F. G.H.
PUMP WELL
CONCRETE
SLUDGE PUMP
A.
SLUDGE AIR PUMP
F.
CONCRETE
OXIDIZERS AND AERATORS
BRICK
WATER INLET
FLOAT PIPE
FLOAT
WASTE PIPE
BRICK
CONCRETE
BRICK
CONCRETE
BRICK
CONCRETE
CONCRETE
ASPHALT
CONCRETE
D.
SUPPLY 18"
AIR TANK
AIR COMPRESSOR
AIR PIPES
H.
B.
SLUDGE AIR PUMP
G.
E.
PLAN
Plan of Plant
for the
PURIFICATION AND SEDIMENTATION
OF
WATER
BY THE
CHEMICO-ELECTRO-PHYSICAL PROCESS
BY MEANS OF
CHEMICAL RE-AGENTS, OXIDATION, AERATION AND SEDIMENTATION.
RENDERING THE WATER CLEAR, SOFT AND FREE FROM MICROBES.
CAPACITY 4,000,000 GALLONS IN 24 HOURS
DESIGNED BY
COL. W. TWEEDDALE
CIVIL & HYDRAULIC ENGINEER
TOPEKA KANSAS
APRIL 1899
SCALE IN 0 12 24 36 48 60 FEET
60
36
2
2'
10'
18" WATER INLET
BRICK
CONCRETE
18"
SUPPLY PIPE
ELEVATION
AIR
BRICK
IRON
COPPER
COKE
CONCRETE
SUPPLY PIPE
PLAN OF OXIDIZER AND AERATOR
AIR
CONCRETE
CONSTRUCTION OF ROOF AND PARTITION
Will W. Smith Del.

tained from our western rivers, an example of which is St. Louis, Mo., which in this manner treats thirty-two million gallons per diem. In Europe, where water purification by the use of sand filters is general, the rate of descent of the water through the sand of the filter varies with the degree of turbidity, ordinarily, but about sixty gallons per square foot per twenty-four hours, or 2,500,000 gallons per acre per diem.

The action of these filters is not alone that of strainers. The fermentation of the organic substances in the bed of the filter changes the organic constituents to inorganic nitrites and nitrates by the agency of bacteria. The mechanical filters act only as strainers, as the rate of passage of the water through the filter, 130 million gallons per acre per diem, is too rapid to allow of the reduction of the organic compounds by fermentation.

In the process of purifying water containing organic matter by filtration, that portion in a state of suspension will be retained on the filter as a strainer, while that carried down by subsidence will be mingled with the other precipitated impurities. In either case they will by decomposition be rendered insoluble, and in the case of the filter will pass off with the filtered water; or in the case of by subsidence will be mingled with the purified water in the settling basin; in each case containing the spores of any bacterial life there may be in the water, together with the soluble matters as a nidus for their development; for which reasons the requirement is to use sand-filtered water soon after it has been purified. The value of filtration as a means for purifying water by the removal of bacteria can be judged from the following:

Doctor Currier, biologist for the Syracuse Water Commission, experimented with a variety of filters, and found, even with the justly celebrated Chamberlain-Pasteur filter, under the hydrant pressure of New York city, when the flow was but drop by drop, that, when the filter had been sterilized by steaming for five hours, no bacteria passed through with the water; but that after three days' continued use the number of bacteria increased to 2500 per cc., and after five days of such use the number had increased to 400,000 per cc. These processes, which may be regarded as standard, take no account of the removal of inorganic substances in solution in water. These substances are earth salts, rendered soluble by the solvent action of gases contained in the water, mainly carbonic and sulphuric acid gases, so objectionable in water used for washing or for use in steam boilers. Doctor Frankland, chemist to the Parliamentary Rivers Pollution Commission in England, regards the softening of water by the removal of lime, magnesia, etc., as so important that he recommended, in a report to the above-named commission, that all companies should be compelled to provide for softening water-supplies before being allowed to raise additional capital for the extension of water-works. It was estimated that the chalk contained in the water-supply of London was 160 tons per diem, and that the saving in soap, if that were removed, would be, approximately, £250,000, equal to $1,250,000; and a cost of one penny applied for purifying water would effect a saving of soap of three shillings and eight pence, or forty-four times as much.

While the character of these impurities has been understood in a general way, it is only of late that any account has been taken of the effects, on nutrition and health, of hard water used dietetically. Based on mortuary statistics of a number of cities, it has been held that the hardness of water had no material effect on the death-rate; and, while it may be true that there is no direct evidence of this, there is much evidence that they exert a marked influence in inducing diseases, causing suffering if not immediate death. The effects produced by the dietetic use of hard water on the animal economy are:

1st. CHEMICAL. An illustration of the chemical effects of such use of hard water can be shown by putting a small quantity of the white of egg in each of two test-tubes, and adding to each the same quantity of bile from a freshly killed animal; then, after agitating for a short period of time, add to one of these tubes a portion of soft water and again agitate, when it will be found that the emulsion formed is perfect, rendering the contents assimilable and fitted for passing into the circulation. To the other tube add the same amount of hard water and agitate, when it will be found that the contents have coagulated into curd-like lumps, similar to soap in hard water, and be no more capable of providing nourishment than so much dissolved stone.

The medical congress held in Brussels in 1886 passed the following resolution: "Waters that are too hard, or that contain mineral substances that do not assimilate with the food and constitute a part of the human system, form with chyle an abnormal medium for the formation of blood, and the presence of these substances in the blood throws additional work on the kidneys, whose duty it is to filter out and remove the wastes of the blood, the too great accumulation of which substances results in the formation of concretions."

2d. PHYSIOLOGICAL. The distinguishing difference in the physical condition of the human system in youth and old age is in the increased amount of deposits of earthy matter. These are carbonates and phosphates of lime mixed with other calcareous substances. These deposits affect the physical organs and interfere with their action, causing imperfect circulation of the blood and clogging of the arteries. The change is in the nature of a slow, steady accumulation; and when they have become excessive the stiffness of old age is produced. As these substances are constituents of the food we eat and of the liquid we drink, much can be done to prevent their injurious effects by a proper selection of food and by providing, for cooking and drinking, a water which does not contain these substances, and also which by its solvent power will dilute not only the substances in the food, forming deposits, but also by acting on the deposits already formed fit them for removal, and thus tend to prolong the elasticity of youth.

3d. MECHANICAL. The nature of the mechanical action of hard water used dietetically on the system will appear when we consider that in the process of combustion of the impurities in the blood the uric acid (ashes of the blood), collected in the kidneys as an ash-pit, must, as in the case of the ash-pit to the furnace, be removed in order to secure efficient action. For this end the requirement is that the fluids passing through the body be in a condition to dilute the uric acid and thus fit it for being carried off by the channels nature has provided for their removal.

When waters used dietetically are charged with earth salts their solvent power is lessened, and they are in a condition to form deposits of the substances they hold in solution in the order of their solubility. Among the least soluble substances in solution in this case, uric acid acts as a nucleus, forming concretions producing paralysis, dropsy, Bright's disease, etc.

Dr. Lewin, of Munich, who made an extended and very careful study of the purification of water, gives the following as the requisites of any system of filtration:

"It must absorb not only substances in suspension but also all matters physically and chemically latent, and must so retain them that additional impure water or clear water cannot wash the impurities out; or purifications must be carried on in such a manner as not to injuriously affect the purity of the water.

The arrangements also should be such as to retain the property of purifying water for a considerable length of time without deterioration."

It is needless to state that this ideal purification of water has not been even approached by any known system of filtration in use. Such being the case, it is allowable to assert that no such system of filtration is possible; from which it follows that the solution of the problem of water purification to the above standard must be sought for outside of present methods, and that any process for the removal of injurious impurities in solution in water physically and chemically latent will be incomplete unless means are provided for rendering all such substances fit for removal by filtration or by sedimentation by making them insoluble and causing them to coagulate and unite with other impurities in suspension.

With the above high ideal of water purification as a standard, the writer has invented an apparatus and a process which in combination provide for the fulfillment of the above conditions.

The apparatus consists essentially of one or more vessels, tanks or reservoirs of any desired form or required capacity, with one or more oxidizers to each tank. These oxidizers are composed of metallic iron and coke arranged to form a galvanic battery, the size and number of oxidizers to depend on the dimensions of the tank, together with the requisite systems of piping for filling the tanks with water, agitating with air, drawing off the purified water, and removing the sludge whenever by its too great accumulation it is found necessary.

PROCESS.

The process fulfills the requirements above enunciated by Dr. Lewin of removing all objectionable impurities in water whether in suspension or in solution, and that, too, without deterioration of the apparatus; and consists

1st. By the use of chemical reagents, changing all substances in solution in water to an insoluble state in suspension.

2d. By combination of the galvanic action of the oxidizer, the salts of iron, and aeration; these substances, now all in suspension, by coagulation and aggregation, are fitted for being precipitated by sedimentation.

REAGENTS.

The reagents for rendering the earth salts, held in solution by the solvent acid gases in the water, insoluble in suspension are alkalis for which the solvent acid gases have a greater chemical affinity than they have for the earth salts held in solution by them. The withdrawal of these acids renders these earth salts insoluble.

The reagents for changing organic substances in water, rendered soluble by putrefactive fermentation, insoluble are metallic iron, coke, and salts of iron.

3d. The treatment consists in introducing into the tank the requisite amount of alkali necessary to absorb the carbonic acid holding the earth salts in solution, then fill with water; during the time of doing so and for the necessary length of time after, by means of compressed air, force the water through the oxidizer. This, in addition to thoroughly mixing the reagents with the water by bringing each particle of water into intimate contact with the material of the oxidizer, oxidizes or burns up the organic matter in solution in the water, thus rendering it insoluble; in addition to which the galvanic action of the oxidizer in the water kills the bacteria and causes the impurities in the water to coagulate. After completion of reaction, test for excess or deficiency of reagents and correct to neutrality if necessary. Then add reagents to absorb the sulphuric acid, and again agitate, test, and correct. After completion of reactions to neutrality, add salts of iron. The effect of this is not only to complete the oxidation of organic matter in solution, but also to hasten coagulation and destroy any excess of alkalinity there may be in the treated water; after which give final agitation and allow the water to become quiescent, when all the impurities in the water, now all in a state of suspension, will be precipitated by sedimentation.

When settled, the water is taken off from near the surface by a floating pipe, clear, soft, free from bacteria, and sterile to the development of micro-organisms.

The rate of precipitation depends on the condition of the water and the temperature. That of the water-supply of the city of Topeka at a temperature of sixty degrees is four feet per hour.

This process, by making a filter of the now all insoluble impurities and by sedimentation, passing them down through the water, instead of by filtration passing the water through the filter, and by the accumulation of impurities in the body of the filter, resulting in the deterioration of the apparatus, provides for the complete realization of Doctor Lewin's ideal water purification, and effects the following results:

1st. The removal from the water of the earth salts renders the water soft.

2d. The removal of the organic matter sterilizes it to the development of micro-organisms and the support of bacterial life.

3d. Aerating the water renders it more palatable, when used for drinking, and allows of the more rapid formation of steam in boilers required for industrial uses.

The cost of installation per square foot of surface will not exceed that for sand filters, while the rate of passage of water will be as twelve to one. The cost of operation will practically be that of the cost of reagent.